3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Quality assurance (QA) for a program consists of two parts: one is an independent assessment of the effectiveness of the measurement program to meet its goals (often denoted as QA audits), and the other is the operational procedures or quality control (QC) necessary to evaluate ability of the measurement process to yield valid data. The Quality Assurance Project Plan defines data quality goals for the project and QC activities necessary to obtain them. These goals are stated in terms of precision, accuracy, completeness, comparability, and representativeness of the data as defined in the following:

- Accuracy is the degree of correctness with which a measurement system yields the true value or bias of an observable (Watson *et al.*, 1989). For the field project, accuracy is quantified comparing the responses of instruments to independent standards or collocated measurements.

- Precision is a measure of agreement among individual measurements of the same observable or repeatability of the measurement. For the field project, precision is quantified by periodically challenging a measurement device with known, identical input conditions.

- Completeness is the measure of the quantity of data collected by a measurement system compared to the total possible amount of data.

- Comparability is a measure of the traceability of the same type of data collected from several different organizations. Comparability can be qualitatively assessed by comparing procedures, QA/QC results, and traceability of standards.

- Representativeness is a qualitative measure of the ability of the collected data to meet the criteria necessary to model ozone formation and transport in the area of interest. Some sites may be source-oriented while others are regional in nature.

QA objectives in terms of accuracy and precision, and completeness of data collected during the field project are presented in the following tables grouped by type of measurement. This information will be updated and expanded in the course of the quality assurance program to include each of the core measurements for SCOS97-NARSTO.

Table 3-1
Data Quality Objectives - Gases - Surface Sites

Observable	Measurement Method	Precision Check	Accuracy Check	Precision Target	Accuracy Target	Completeness
Ozone	UV absorption	Weekly precision check	UV photometer	±15%	±15%	80%
NO/NO_y	Chemiluminescence with external converter	Weekly precision check	NO gas standard/ Dilution system	±15%	±15%	80%
NO/NO_x	Chemiluminescence with nylon inlet filter	Weekly precision check	NO gas standard/ Dilution system	±15%	±15%	80%

Table 3-2
Data Quality Objectives - Meteorological Data -Surface Sites

Observable	Measurement Method	Precision Check	Accuracy Check	Precision Target	Accuracy Target	Completeness
Wind Speed	Anemometer propeller or cups	None	Constant RPM motor	None	±0.25 m/s for WS<5m/s ±5% for WS>5m/s	90%
		Starting Threshold Torque wheel			< 0.3 g-cm	
Wind Direction	Vane	None	Alignment with true North	None	±5°	90%
Ambient Temperature	Thermal Resistance	None	Collocated Thermistor	None	±0.5 °C	90%
Relative Humidity	Capacitive or resistive	None	Collocated Capacitive	None	±10%	90%
Dew Point	Computed or dew cell	None	Collocated Ca Capacitive RH	None	±1.5 °C	90%
Solar Radiation	Pyranometer	None	Precision Spectral Pyranometer	None	±25 w/m^2	90%

Table 3-3
UCD Aircraft Instrumentation

Parameter Measured	Technique	Manufacturer	Time Response	Measurement Range	Accuracy
Pressure (Altitude)	Capacitive	Setra	1 s - 3 s	-30 m - 3700 m	± 0.3 mB ± 3 m
Temperature	Platinum RTD	Omega	1 s - 3 s	-20°C - 50°C	± 0.2°C
Relative Humidity	Capacitive	Qualimetrics	1 s - 3 s	10% - 98%	± 3%
Air Speed	Thermal Anemometer	T.S.I.	1 s - 3 s	15 m/s - 75 m/s	± 0.4 m/s
Heading	Electronic Compass	Precision Navigation	1 s - 3 s	0° - 359°	± 2°
Position	GPS	Garmin	10 s	Lat. - Long.	± 15 m
Particle Concentration	Optical Counter	Climet	10 s	2 channels: d > 0.3 μm & d > 3 μm	± 2%
NO, NO_2 Concentration	O_3 Titration Chemilumin.	Monitor Labs.	10 s - 15 s	0 ppmv - 20 ppmv	± 0.5 ppbv
Ozone Concentration	UV Absorption	Dasibi 1008	10 s - 15 s	0 ppbv - 999 ppbv	± 3 ppbv

Table 0-4
STI Aircraft Instrumentation

Parameter Measured	Technique	Manufacturer	Time Response	Measurement Range(s)	Accuracy[a] (Full Range)
NO/NO_y Concentration	Chemilumin.	Thermo Env. Model 42S	< 20 s	50 ppb, 100 ppb, 200 ppb	± 10%
Ozone Concentration	Chemilumin.	Monitor Labs. 8410E	12 s	200 ppb, 500 ppb	± 10%
b_{scat}	Integrating Nephelometer	MRI 1560 Series	1 s	100 Mm^{-1}, 1000 Mm^{-1}	± 10%
Dew Point	Cooled Mirror	Cambridge Systems 137-C	0.5 s/°C	-50°C - 50°C	± 10%
Altitude	Altitude Encoder	II-Morrow	1 s	0 m - 5000 m	± 10%
Altitude (backup)	Pressure Transducer	Validyne P24	< 1 s	0 m - 5000 m	± 10%
Temperature	Bead Thermistor/ Vortex Housing	YSI/MRI	5 s	-30°C - 50°C	± 10%
Temperature (backup)	Platinum Resistance	Rosemont 102 AV/AF	1 s	-50°C - 50°C	± 10%
Position	GPS	II-Morrow	< 1 s	Lat. - Long.	± 50 m
Data Logger (includes time)	Dual Floppy Acquisition	STI 486 System	1 s	± 9.99 VDC	± 10%
NO/NO_w[b]	Chemilumin.	Thermo Env. Model 42S	< 20 s	50 ppb, 100 ppb, 200 ppb	± 10%
SO_2[b]	Pulsed Fluorescence	Thermo Env. Model 43S	15 s	1 ppb, 5ppb, 50 ppb,200 ppb	± 10%
CO[b]	Gas Filter Correlation	Thermo Env. Model 48S	< 20 s	1 ppm, 2 ppm, 5 ppm, 10 ppm	± 10%

[a] For values between 10% and 90% of full scale

[b] Without modifying the aircraft for additional power, only one of these three instruments can be operated.

Table 0-5: CE-CERT Ozonesonde, Data Quality Indicators and Goals

DQI	Goal
Precision	1-sigma < larger of 5 ppb or 10%
Calibration Bias	1-sigma < larger of 5 ppb or 10%
Interference Bias	-10 to + 50 ppb
Lower Quantifiable Limit	< 15 ppb
Response Time	> 80% of step change in 1 minute
Ascent Rate	< 3.0 m/s
Response Distance	> 80% in 180 meters
Time of Launch	+/- 3.0 hours from planned time
Location of Launch	+/- 100 meters from planned location
Duration of Flight	>3000 meters AGL

Table 0-6: CE-CERT Meteorological Instruments, Data Quality Indicators and Goals

Measurement	DQI	Goal
Temperature	Precision	± 1 °C
Temperature	Calibration Bias	± 3 °C
Temperature	Response Time	> 63% response in 20 s
Pressure	Precision	± 2 mb
Pressure	Calibration Bias	± 5 mb
Pressure	Response Time	> 63% response in 2 s
Relative Humidity	Precision	± 5% RH
Relative Humidity	Calibration Bias	± 10% RH
Relative Humidity	Response Time	> 63% response in 2 min

Table 3-7

Quality Assurance Objectives for Upper-Air Meteorological Measurement Data

Measurement Method	Variables Measured	Systematic Difference (Bias)	Comparability (RMS difference)	Data Recovery % of Observations to Given Height
RASS	T_v	±1 °C	1.5 °C	50%, 1000 m
RWP	WS, WD	WS: ±1 m s^{-1} WD: ±10°	WS: 2 m s^{-1} WD: 20°	50%, 3000 m
Sodar	WS, WD	WS: ±1 m s^{-1} WD: ±10°	WS: 2 m s^{-1} WD: 20°	50%, 500 m
Rawinsonde	WS, WD, T, T_d, RH, p	WS: ±1 m s^{-1} WD: ±10° T: ±1 °C Td: ±2 °C RH: ±0% P: ±1 mb	WS: 2 m s^{-1} WD: 20° T: 1.5 °C Td: 3 °C RH: 10% P: 2 mb	90%, 5000 m

Table 3-8
Data Quality Objectives for VOC and Related Measurements

Observable	Measurement Method	Number of Species	Detection Limit	Precision Target	Accuracy Target	Completeness
C2-C11 hydrocarbons	Canister GC-FID	57 to 150	0.1 ppbC	± 5%	± 15%	90%
Methane	Canister GC-FID		20 ppbv	± 5%	± 15%	90%
CO	Canister GC-FID after conversion to methane		20 ppbv	± 5%	± 15%	90%
CO2	Canister GC-FID after conversion to methane		3 ppmv	± 5%	± 15%	90%
MTBE	Canister GC-FID		0.1 ppbv	± 5%	± 15%	90%
Carbonyl Compounds	DNPH - HPLC/UV	3 to 14	1 ppbv	± 10%	± 20%	90%
Halogenated Compunds	GC-ECD	Perc and CH_3Cl_3	0.01 ppbv	± 5%	± 15%	90%